Notebook, N-88-09-28

This notebook, which covers the period September-October 1888, is a continuation of N-88-08-28. It contains transcriptions by Arthur E. Kennelly of material from the rough record books used by experimenters in the Galvanometer Room. Included are notes, drawings, tables, and calculations regarding meter and multipolar dynamo experiments, phonograph battery tests, and tests of an electric motor to run a blower at the phonograph factory. Some of the entries relate to the transmission of power from Niagara Falls to Buffalo and to physiological experiments using gasoline on bacteria. Among the experimenters whose work appears in this book are F. P. Bergh, E. C. Boynton, Alex W. Brigham, Johannes H. Cuntz, T. F. Lawrence, and Charles Wirt. The front cover is labeled "#525" and "Record Book No VI Galvanometer Room." The spine is labeled "78." The book contains 56 numbered pages.

Two oversize graphs, formerly pasted onto pages 42 and 51, have been filmed at the end of the book at a reduction ratio of 18:1.

XE-172 N-88-09-28

Record Book

No VI

of Observations Calculations and

Data in the Galvanometer

Room Edison Lab.ry

Commenced 30th September 1888.

Meter Experiments cont.

29th September. Tested the sp. g. of the new F2 solution prepared yesterday.
By Hydrometer 1·415 @ 20·1°C

Took a series of readings similar to those of yesterday, with the plates reamalgamated and washed. The varnish lent by Mr Watt consisting of a mixture of asphalt and rubber was not successful so far, in the manner adopted.

The following table gives readings both with ~~both~~ and without hale flanks:—

No	Time	Plates	Bridge	Res.	Mun.	T.Z.	F2		
						with hale flanks			
1	11:0	½" intermediate hale side	100 m/o T.B. 19.9	1400	1	0.590	0.54		
2				707	10	0.55	0.55		
3		Temp 20°C		105	50	0.56	0.54		
4				28	250	0.49	0.47		
5		½" intermediate hale side	100 m/o	7000	1	0.52	0.52		
6				670	10	0.53	0.52		
7				100	50	0.53	0.51		
8		Temp 20°C		2	250	0.51	0.50		
9	17.05	½" intermediate hale side	100 m/o T.B. 19.5°C	6000	1	1.24	1.49		
10				650	10	1.35	1.30		
11		T. 23.5°C.		100	50	1.38	1.35		
12				1	250	0.76	0.76		
13	17.10	½" intermediate hale side T. 23.5°C.	100 m/o T.B. 19.5°C	6000	1	0.99	0.89		
14				650	10	0.91	0.97		
15				100	50	0.88	0.86		
16				1	250	0.73	0.71	?	

Meter Experiments contd.

Set solution in hot water and took the resistance when the temp. had attained the steady maximum.

No.	Time	Plates	Temp. C	Bridge	Resistance	Max	T.L. (cold junc. 0°)	T.L. (cold junc. 15°)	
1	16·39	½" inlet	49°	100 ω T. 19°C.	100 ω	50	0·27	0·27	8·56
2	·47		61°				0·33	0·32	18·5
3	·53		65°				0·43	0·41	23·7
4	17·10		86°				0·88	0·86	49·8
5	·42		102				1·67	1·64	95·0
6	·52		119°				2·19	2·14	124·0
7	16·40	½" inlet	100°	100 ω T. 19°C.	100 ω	50	0·26	0·25	
8	·45		118				0·31	0·30	
9	17·10		24°				1·38	1·35	
10	·40		40°				2·07		
11	·54		46°				2·88	2·81	

* Crystals were forming just about the lowest temperature.

29th Sept. Filtered solution afresh and after doing so recovered about 470 c.c. The sp. g. by Hydr. after filtering was 1·419 @ 21·3°. Water was then added to the extent of 60 c.c. so as to retain 80% of the primitive solution and the sp. g. then was 1·395 @ 22·8°C by Hydr. 1·370 @ 23·5°C by volum.

About 5 c.c. were lost by spilling.

The lamp in the hot meter under trial was found to be extinguished in the afternoon being thereby perhaps 20 hours heat altogether.

Motor Experiments. cont.

The following readings were then taken:—

No. Obs.	Time	Plate	Bridge ft.	Rec.	Mr	Corrected for Ends of T.I.	Corr. for Ends of F.I.	λ_f ft
1	10.30	½" heated.	100 to 17.9°C.	7470	1	0.20	0.22	29.50
2		23.4°C		720	10	0.27	0.25	
3				115	50	0.26	0.25	
4				5	250	0.26	0.25	
5		½" heated. 23.4°C.	100 to 17.9°C	7000	1	0.41	0.41	23.70
6				870	10	0.44	0.41	
7				95	50	0.43	0.42	
8				1	250	0.43	0.42	
9		½" heated.	100 to 50	110	50	0.17	0.17	19.7
10			68°	-	50	1.75	1.74	201
11			26.5°	-	50	0.60	0.59	68.3
12		½" heated	100 to 58°	110	50	0.25	0.25	14.5
13				-	-	1.76	1.73	100.
14		½"	26.5°	-	-	0.72	0.70	40.5

Crystals seemed to be just about to form at this low temperature.

The area of the water between the plate is

$0.5 \times 14.25 = 0.127 \div 2 = 0.0635$ sq ft $= 1.27$ sq inches

$76 - 2.5 = 73.5$

$73.5 \div 0.0635 = 115.8$

$73.5 \div 1.27 = 57.9$

The depression has for the ½ plate risen from 14.5 to 100 for a fall of 44.2°C = 85.5 nearly .2% per °C. falling

or kept coeff. or $\frac{85.5}{44.2}$ - 16% - °C rising

or $\frac{100}{44}$

The mean temp in Meter no 1 has been about 43°C. that in - - 2 - - - 24°C a difference of 19°.
= 1% of error for $\frac{19}{4.5}$ or 4.2°C.
9°F

Meter Experiments cont. — Sunday 30th Sept (K)

Took down the meters that have been at work during the past week.
They have received current 17 hours a day for 6 days at mean rate of about 3.75 ampere = 420 ampere hours = 1,512,000 Coulomb.
So that about 1,512 Coulomb have passed through the bottles and so each Coulomb transfers 3.367×10^{-14} gms. we should expect about 0.51 gms of transfer. This will be the superior limit because for some hours the current has been cut off.

Bottle No.	Weight 23rd Sept. Single	Pair	Sum of pair	Weight 30th Sept. Single	Pair	Sum of pair	Gain	Loss
1	87.2018	175.5018	175.5025	87.6567	175.4775	175.4773	0.4549	0.4801
2	88.3007			87.8208				0.0236
3	89.4658	179.3960	179.3972	89.9576	179.4250	179.4252	0.4918	0.4638
4	89.9312			89.4676			0.0290	
5	87.9560	176.7244	176.7250	87.5139	176.7507	176.7515	0.4656	0.4621
6	88.7720			89.2376			0.0257	
7	87.9807	173.8351	173.8346	87.5330	173.8567	173.8570	0.4701	0.4477
8	85.8539			86.3240			0.0216	
				Mean loss of hot cell				0.472
								0.450
								22
								or 4.9%

It is noticeable that the bulk of the lamp rated under normally below filling 1.2 phase 5.4 which may account for the extra loss that is. The all other that some material of the insertion of the wire in the top [illegible]

Calculation for the rough conditions of transmitting 5000 H.P. from Niagara to Buffalo.

5000 HP = 3750,000 Watts. approx.
The distance is stated at 23 miles.

@ 1000 volts	this is equivalent to	3750 amperes
@ 2000	-	1875 -
@ 3000	-	1250 -
@ 4000	-	938 -
@ 5000	-	750 -
@ 6000	-	625 -
@ 7000	-	536 -
@ 8000	-	469 -
@ 9000	-	417 -
@ 10000	-	375 -

There is no great advantage therefore in exceeding 5000 volts at the Buffalo end say. Then assuming no loss in the line due to leakage we have :—

Allowing 5% loss through friction in wire

$(750)^2 r = \frac{5000}{20} = 250\,273 \times 10^{-6}\ r = \frac{250}{750} = \frac{1}{3}\omega = 0.0146$ ohms

Allowing 10%	$562500\ r = \frac{500}{750}$	$= 0.66\omega$	$= 0.0288$
- 15%	$-219\ \mu\ r =$	$= 1\omega$	$= 0.0432$
- 20%	$1092\ \mu\ r =$	$= 1.33$	$= 0.0576$
- 25%	$13.65\ \mu\ r =$	$= 1.66\omega$	$= 0.0721$
- 30%	$r =$	$= 2.0\omega$	
- 35%	$r =$	$= 2.33\omega$	
- 40%	$r =$	$= 2.66\omega$	
- 45%	$r =$	$= 3\omega$	
- 50%	$r =$	$= 3.33\omega$	

Hence allowing in the line a frictional loss of

5% requires a wire 0·33ω total res = 0·0144ω per mile = $2{\cdot}73 \times 10^{-6}$ per foot =

10% " " 0·66ω " = 0·0288ω " = $5{\cdot}46 \times 10^{-6}$ " "

15% " " 1·0ω " = 0·0432ω " = $8{\cdot}19 \times 10^{-6}$ " "

20% " " 1·33ω " = 0·0576ω " = $10{\cdot}92 \times 10^{-6}$ " "

25% " " 1·66ω " = 0·0721ω " = $13{\cdot}65 \times 10^{-6}$ " "

The largest wire usually strung overhead is #4 B.W.G. 0·238" diam. having $182{\cdot}7 \times 10^{-6}$ ω per foot so that to lose frictionally 5% would require 6¾ #4 wire

" " 10% " 3¼ " "

" " 15% " 2¾ " "

" " 20% " 1¾ " "

" " 25% " 1¾ " "

It is doubtful if the insulation could be maintained higher with ordinary telegraph insulators even the very best than 250,000ω per mile in all weathers that is 11,000ω for the whole line

With 6¾ wire this would be a total ω of 170ω

" 3¼ " " 340ω

" 2¾ " " 580ω

" 1¾ " " 650ω

" 1¾ " " 800ω

The leakage of current in the 1st case would be roughly 3½ amperes

" " " " 2nd " " " 1¾

" " " " 3rd " " " 1¼

" " " " 4th " " " ¾

At least 5% must therefore in any case be deducted from the efficiency for leakage.

Hence revised the figures stand as follow

For 10% total loss in line 4,000,000 cm 2" diam Wire or 67 ft 4 B&W wire

15%	2,000,000	1.5" diam wire	34 ft 4	
20%	1,330,000	1.15"	23 ft 4	
25%	1,000,000	1.0"	17 ft 4	
30%	800,000	0.9"	13 ft 4	

It would probably pay to employ 10 motors wound for a counter emf of 5000 volts each to deliver 500 H.P. at full load and each to transform through gearing to 200 volts and delivering at that pressure 1800 amperes.

Meter Experiments contd.

Monday 1st October :—

Recovered 489 c.c. of the 80% $ZnSO_4$ solution. Its sp. g. by Hydr: was 1.390 @ about 22°C.

Added 70 c.c. of distilled water to produce 70% solution.

The sp. g. then was:— 1.355 @ 21.6°C by Hydr
1.325 @ 24°C : balance

Tuesday 2nd October :— Sp. g. of solution 1.355 @ 25°
Tests with 70% Solution @ follows:—

No.	Plate	Time	Bridge temp.	Rev.	Ma.	TZ (c.c. for Cond. 0.34)	FZ	sp. r.
1	½" int. blued	14.05	temp. 25.5°C	7205	1	0.59	0.49	
2	Temp. 24.9°	14.10	—	675	10	0.52	0.53	
3		14.12		105	50	0.53	0.52	
4		14.13		5	250	0.49	0.49	
5	½" int. blued	14.15		6802	1	0.48	0.40	
6		14.16		652	10	0.46	0.46	
7	24.9°	14.17		100	50	0.42	0.41	
8		14.18		4	250	0.38	0.32	
9	25.8°	14.40		102	50	0.15	0.15	
10	½ -	.40½		102	50	0.25	0.24	
11	½ 24.9°	17.10		104	50	0.88	0.85	
12	½ -	..		104	50	0.71	0.70	

Unable to employ lower temperature not having ice.

Made up a new solution of 1337 grms of Wht Zinc Sulphate in 1000 c.c. of distilled water & left it to settle

Mean temp of meter under test @ 11.0 1.10.88 at 31°C sg
" - - - - - - 13.30 1.10.88 - 31°C 3.40
" - - - - - - 10.0 : : 31.5°C 3.36
" - - - - - - 14.0 : : 30°C

Back Rev. 85 Pres. 55

1.30
17.53

Front Rev. 85 Pres 55
Total H.P. 35.51

1.12
17.98

Phonograph Factory Data:

2

Set up a motor # 6 on the 29th Sept: in the Office Factory building to run the shafting there.

The conditions on Monday 1st Sept: were as follows.

Speed of Motor 1000 revs: amperes 68 volts about 100
" " shafting 200 " Diam. 38"
" " Intermediate 420 " Diam. 18" 30"
" " Blower 2400 " " 9"
Pressure in cupola under load 6 oz: Water:

Took Diagrams of power given by engine when motor not running and the mean was about 33 H.P., two diagrams being appended.

Meter Experiments contd.

Tuesday 2nd October.

Made up a solution as mentioned on p 1 of 1337 grms $ZnSO_4$ + 1000 water.

Wednesday 3rd October

The solution having free crystals of $ZnSO_4$ added 100 c.c. H_2O dist.

Temp. of Not meter above cool 16.2°C. @ 18.0. 2.10.18

Discovered on the morning of the 4th Oct. that the meter test was useless owing to a mistake in the connection. Took it down and reset it. Cleaned and remelgamated plates weighed as follows 88.10.5. 16-18.

Plate	Weight	Paper	Weight of plate	Sum of pairs	Weight of couple	Weight of one plate	Diff
1	87.5837	0.7386	86.8451	174.3970	175.1369	174.3985	0.00084
2	88.2910		87.5524				
3	90.7968		90.0582	178.0894	178.8293	178.0907	0.0013+
4	88.7698		88.0312				
5	92.4444		91.7028	182.0906	182.8292	182.0921	0.0000
6	91.1264		90.3878				
7	88.6255		87.8869	175.8562	176.5938	175.8552	0.0010
8	88.7079		87.9693				

Meter Experiments cont. –

October 3rd.

Sp. g. of 70% solution last used after filtration 1·355 @ 20·1°C by Hyd.

Amount 528 cc

Added 93 cc. of distilled water to reduce to 60%

Sp. g. of 60% solution as made 1·322 @ 20·8° by Hyd.
1·286 @ 26°C – below

Sp. g. of distilled water by balance 0·9985 @ 22·5°C.
correction for thermometer fully – 2·5°

Took following series after remelgamating roomsifice

No.	Time	Platu Temp	Bridge 1/2	Res.	Mes	T.I. with per cent 0·24	F.I.
1	14·58	½° 21°C	22·5° 1000/10	7400	1	0·31	0·26
2	15·00	-	-	720	10	0·265	0·25
3	15·01	-	-	1145	50	0·26	0·255
4	15·03	-	-	·3	250	0·26	0·253
5	15·05	½° 21°	-	6400	·1	0·446	0·446
6	·06	-	-	650	10	0·446	0·438
7	·07	-	-	100	50	0·446	0·438
8	·09	-	-	2	250	0·446	0·43
9	·30	½ 53·2°	-	94	50	0·20	0·19
10	·31	½ 53·3°	-	"	-	0·12	0·11
11	16·28	¼ 4·8°	-	-	-	1·71	1·71
12	·30	½ 4·4°	-	-	-	1·66	1·62

Crystal just forming at the low temperature.

Motor boat south –
Thursday 21st October.
Recovered after filtration 500 odd c.c. sp.g. 1·3250 @ 18·5°
by Hydr.
added 100 c.c. of distilled water to reduce to 50%.
sp.g. then by Hydr. 1·255 @ 18·9°C
balance 1·2474 @ 19·5°C.

Took following series, after reamalgamating and revarnishing plates.

No.	Time	Plate	Purity	Res.	Mag.	F.Z.	F.Z.	
1	14.15	½" 19.5	100%	7500	1	0.41	0.39	
2	.16		.19.2C	720	10	0.39	0.37	
3	.17			111	50	0.39	0.37	
4	.20			5	250	0.35	0.34	
5	.22	½ 19.5		7200	1	0.55	0.49	
6	.23			720	10	0.51	0.49	
7	.25			105	50	0.50	0.49	
8	.26			2	250	0.48	0.48	
	In heating this solution the teacher broke and solution lost. Made new solution.							
9	14.51	½ 19.5	100% 20.3C	7200	1	0.50	0.50	
10	.52			700	10	0.67	0.67	
11	.55			110	50	0.67	0.66	
12	.56			5	250	0.61	0.60	
13	.59	½ 19.5'		6000	1	0.45	0.45	
14	16.00			650	10	0.43	0.42	
15	.01			100	50	0.43	0.41	
16	17.02			10.0	250	0.37	0.34	
17	.30	½ 49.1		92	50	0.14	0.13	
18	.34	½ 48.8'		4	"	0.26	6.25	
19	.40	½ 3.8'		"	-	1.57	1.55	
20	.41	½ 3.9'		"	-	1.14	1.14.	

Bacteria Experiments

September 28th

Subjected a solution of pepsin in common water to a temp. of 23-25° C. One drop of this solution was observed to contain microbes. After examination added one drop of a 6.5% sol. NaHO. After the addition no movement could be discerned.

Another drop of the same pepsin solution was observed to contain moving microbes. Added one drop of gasolene after which no movement was discerned.

A drop of solution of egg (that had been breeding for some time) was observed to contain moving microbes. After the addition of one drop of 6.5% sol. NaHO to the slide, no movement was observed.

Took a square meter of slightly inclined ground in the courtyard, and marked off inside it and symmetrically a square of 45 cms. Poured evenly over the surface of the center square about 2000 cc of gasolene, and immediately afterward poured 60000 cc of common water over the whole square meter with a sprinkler. Next after the lapse of one hour removed with a trowel a section of area 5 cm X 12.5 cm. and from

the surface to a depth of 23·5 cm.

On making chemical analysis of the filtrate from this quantity of earth found about 12·5 % of the original strength of solution (including the $NaClO_3$).

Sept. 29th. Captured a fly (commonly called Daddy Longlegs) and placed it inside an evaporating dish. About 1 cc of gasoline in a separate small vessel was introduced into the inverted evaporating dish as also a caterpillar. These animals were thereafter left exposed to the gasoline vapor. The fly died apparently in about 3 mins. the caterpillar in about 2 hours. (5 mins. 20 secs.)

Oct. 2nd. Took a battery jar, & filled it with well settled red fine sand. Poured over the surface the following amount of $NaClO$ 44·2 c.c. = 0·20 gm. by sp. g. of solution by balance = 1·066. This was poured on at 11 o'clock.

Tested this sand after it had remained untouched in the open air for 4 hours. Took a central section by means of a glass tube and then divided this sectional shaft of sand into upper, lower and middle thirds. The top had 16 c.c. of earth, the middle 8 and the bottom 15. Found by chemical analysis that 72 % of the quantity supposed to have been poured on the test area was present in the upper third, none in the lower or middle.

Took a glass tube 175 cms long and 5 cms in int: diam. At the lower end this was drawn down to a 2 cm diam circular opening, and a plug of cotton waste there inserted reaching about 5 cms into the tube. Prepared some white sand by thoroughly washing it and drying it in a sand bath. Filled the tube with this dry white sand to within 30 cms of the top thus retaining a column 1140 cms long. Poured over the top of the column in the vertically held tube 713 cc of NaHO solution 6·5%. This rapidly descended the column as the colour evidenced the rate being about 0·22 cms per sec: at outset. The liquid was collected as it ~~was~~ filtered through in a bottle beneath, and the filtrate tested. It was found to be a 6·2% solution and consequently to have only lost about 5% of the original strength. The experiment lasted 3 hrs + 30 mins.

Set a small copper water bath over a kerosene lamp chimney to work at 18·0

2.10.88 with 5 beakers in it

no 1 contained solution of ——— in common water.
(2) – – – papain – –
(3) – – – CaO – –
(4) – – – $NaCl$ – –
(5) – – – $NaHO$ – –

Bacterio Observations.

October 4th. Temp. of nest 27°C.
after 18 hrs. - - - 23°C.
- 41 - - - 27°C.

The duckmeat was not introduced till after the 41st hour.

Pepsin solution was observed to contain both microococci and bacteria.

One drop of this solution adulterated with one drop of HgCl₂ 1/1000 showed no movement after an hour. Perhaps dried?

Repeated experiment under exactly same conditions but observed life after 15 mins.

Repeated experiment adulterating with one drop of 1/1000 HgCl₂. After 30 mins. life was still viable.

Repeated experiment adulterating with one drop of 1% HgCl₂ after some time life was still viable.

Repeated experiment adulterating with one drop of concentrated ordinary solution of HgCl₂. Life was still viable.

These results being so anomalous tested the HgCl₂ solution found that it probably contained an oxychloride of mercury from absence of acidity. Made up a new solution rendered slightly acid by HCl.

On repeating last adulterating with one drop of concentrated solution. Found it killed

Microbes. Experiments

October 4th.

Placed a little black snake about 10 cms long) under a goodsized evaporating dish with about 10 cc. of gasolene in a small phial. Death was produced in about 30 minutes.

October 5th.

Took one drop of pepsin solution and finding life in it adulterated with 1 drop of $HgCl_2$ new solution $\frac{1}{1000}$. No movement then perceived.

Repeated experiment with same result.

Tried several ~~drops~~ minute of pepsin solution drops adulterated with $ZnCl_2$ concentrated. So far as could be discerned this did not kill microbes.

Two tests with chromic acid in the same way $\frac{1}{500}$ + $\frac{1}{1,000}$ seemed to kill microbes.

One test with gasolene one drop of gasolene to four of pepsin solution seemed to show that the movement of the bacteria ceased but the smaller micrococci seemed to show movement.

One test with NaHO solution concentrated 6.5% solution did not seem to kill either the larger or the smaller.

Temp: of rest 28° C.

Meter Tests cont'd —

Betrip 4.4

Recovered after filtration 480 c.c. of 50% sol. sp. g. 1.268 @ 16.9 by B. Hydr.

Added 120 c.c. of H_2O dist. to reduce this to 40% sol. The sp. g. then being 1.18444 @ 18.2°C by balance

1.225 @ 16.6°C. B. Hydr.

Made following measurements with this solution.

No of Obs.	Time	Plate	Bridge	Res	Mes	Converted to Case 2 25 F.L.		Sp. c.
1	9.43	½" 4.8°	100% sp. g. 22°C	7400	1	0.70	0.50	
2	.46			725	10	0.50	0.47	
3	.47			110	50	0.48	0.47	
4	.48			3	250	0.47	0.46	
5	.50	½" 4.8°		6800	1	0.70	0.25	
6	.51			675	10	0.45	0.28	
7	.53			105	50	0.30	0.28	
8	.55			2	250	0.28	0.27	
9	10.12	½ 48.8°		110	50	0.25	0.24	
10	.14	½ -		110	50	0.17	0.17	
		Breakers have been made over solution						
11	13.26	½ 20.8°	22.5°	7400	1	0.50	0.50	
12	.27			700	10	0.52	0.50	
13	.28			110	50	0.51	0.50	
14	.30			4	250	0.51	0.50	
15	.32	½" 20.8°	"	6050	1	0.55	0.25	
16	.33			620	10	0.32	0.28	
17	.34			104	50	0.31	0.29	
18	.35			0	250	0.28	0.26	
19	14.10	½" 48.1°		92	50	0.34	0.14	
20	.11	½" 47.5°		"	"	0.24	0.23	
21	15.27	½ 2.5°		"	"	1.11	1.09	
22	.28	½" 2.5°		"	"	0.76	0.75	

Meter Experiments contd:—

The solution employed after the fracture of the beaker mentioned on the preceding page was:— 80 c.c. of solution 40% left in bottle replenished with 160 c.c. of concentrated Wilmotts pure H_2SO_4 and 240 H_2O. The density being 1.170 @ 22.0°C by balance.

October 5th Saturday:—

Recovered after filtration 467 c.c. of 40% solution. Added to this 156 c.c. of distilled water making 623 c.c. of 30% strength. Before the addition of the H_2O the sp. g. was 1.225 @ 21°C by B. Hyd.
after the addition . . . 1.140 @ 21.6° " Hyd. sp. g.
1.140 @ 22.5°C . Balance

Took following series

No.	Time	Photo Temp	Bridge	Res.	Mu	Not for tests 2 & 3 T.E.	FE
1	14.46	½° 21.5°	100%	7400	1	0.50	0.50
2	.47			700	10	0.49	0.48
3	.48			115	50	0.49	0.48
4	.50			5	250	0.48	0.48
5	.52	½° 21.5		6900	1	0.38	0.30
6	.53			750	10	0.29	0.28
7	.54			110	50	0.28	0.28
8	.55			3	250	0.28	0.27
9	15.10	½° 52.0		112	50	0.15	0.15
10	.12	½° 52.7		112	50	0.28	0.27
11	.58	½° 40.0°		112	50	0.37	1.35
12	16.00	½° 39.9°		112	50	1.25	1.24

Meter Experiments contd:—

October 5th Friday.

Took the Resistance with Mr Wirt of the 4 12 light and also of the 4—25 light meter batteries in series which have been left standing untouched since the 13th September — a lapse of 22 days see No V p. 40. Results as follows:—

Reading No.	Time	Number of Minutes after commencement	Bridge	Resistance	Mass	Battery	Corrected for Capacity F.Z. T.Z.	F.Z.	Mean Resistance per Tube
1	10·50	0	100%	7000	1	4-12 lt. 21·0	75·75		19·7
2	·55	5	-	-	-		72·75		18·2
3	11·00	10	-	-	-	- -	71·75		17·9
4	·05	15	-	-	-	- -	67·75		16·9
5	·08	18	-	-	-	-	66·75		16·7
6	·09	19	-	-	-	2 batts only on circuit	30·25		15·1
7	·10	20	-	-	-	4 batts open	66·25		16·6
8	·15	25	-	-	-	-	64·75		16·2
9	·20	30	-	-	-	- -	62·75		15·7
10	·25	35	-	-	-	-	61·25		15·3
11	·35	45	-	-	-	-	59·25		14·8
12	·45	55	-	-	-	-	57·75		14·2
13	12·00	70	-	-	-	-	54·25		13·6
14	13·20	150	-	-	-	-	45·05		11·26
15			-	-	-	4 25 lt batts 21·0	52·75		13·2
16				0	250		9·25		2·31

Meter Experiment cont. –

October 8th Friday

Took the plates which looked clean but much rubbed out of the bottles used in the last test and thoroughly cleaned them. They were then reamalgamated, remounted and set up again. The density of the solution in the bottles was tested and found to be slightly in excess of 1.0446.

These bottles were then connected as before in series. i.e. {4 12-light bottles} and the following measurement made 4 25 . . .

No of ch.	Time	Bottle Temp.	Bridge	Resist.	Mass	Deflect for T.Z.	Deflect F.Z.	Mass per bottle T.Z.	
1	16.50	4.4 to 2.0	100 m/m	7000	1	10.45	10.25	2.61	
2				1500	5	10.45	10.25	2.61	
3				700	10	10.44	10.25	2.61	
4				310	20	10.40	10.15	2.60	
5				10	250	9.80	9.15	2.33	
6	17.50	4.2 to 2.0	100 m/m	7000	1	5.25	not det.	1.31	
7				310	20	5.25	–	1.31	
8				0	250	5.07	–	1.26	

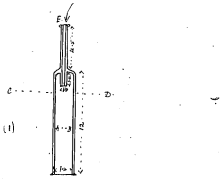
The bottles were then left in the showroom without current (disconnected) for future tests.

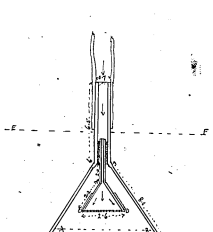
Resumé of Specific Res: Measurements of various $ZnSO_4$ solution densities to date.

No. of Expt.	Date 1906.	Solution used	Sp. g.	Res. 4 T.Z. of (init. 1/16") plate			Res. 6 T.Z. of (init. 1/8") plate			
				Res. in equilibrium at 25°C.	Res. at entire immersion	Res. in equilibrium at 45°C.	Res. in equilibrium at 25°C.	Res. at entire immersion	Res. in equilibrium at 45°C.	
1	9/05	100%	1·143	0·[illegible]0 ± 0·[illegible]	0·[illegible]0 ± 0·[illegible]	1·13 ± 0·7°	0·32 ± 0·05°	0·246 ± 0·00°	0·232 ± 7·0°	
2	9·28	90%	1·205	0·[illegible]0 ± 0·[illegible]	0·[illegible]0 ± 0·[illegible]	2·18 ± 0·4°	0·90 ± 0·25°	0·270 ± 0·00°	2·19 ± 0·4°	?
3	9·29	80%	1·370	0·37 ± 0·[illegible]	0·37 ± 0·[illegible]	1·720 ± 0·8°	0·240 ± 0·22°	0·230 ± 0·00°	1·76 ± 0·5°	
4	10·1	70%	1·325	0·42 ± 0·[illegible]	0·15 ± 0·[illegible]	—	0·230 ± 0·22°	0·230 ± 0·01°	—	
5	10·3	60%	1·286	0·26 ± 0·2°	0·12 ± 0·33°	1·11 ± 0·5°	0·240 ± 0·21°	0·230 ± 0·02°	1·66 ± 0·[illegible]	
6	10·12	50%	1·247	0·240 ± 0·[illegible]	0·[illegible] ± 0·[illegible]	1·14 ± 3·3°	0·270 ± 0·18°	0·260 ± 0·16°	1·570 ± 3·5°	
7	10·5	40%	1·184	0·310 ± 0·[illegible]	0·[illegible] ± 0·[illegible]	0·75 ± 2·5°	0·310 ± 0·20°	0·240 ± 0·02°	1·11 ± 2·7°	
8	10·6	30%	1·140	0·330 ± 0·[illegible]	0·150 ± 0·10°	0·35 ± 0·29°	0·290 ± 0·22°	0·250 ± 0·02°	1·370 ± 6·0°	
9	10·8	20%	1·096	0·315 ± 0·[illegible]	0·170 ± 0·11°	1·405 ± 0·6°	0·89 ± 0·20°	0·370 ± 0·01°	2·11 ± 0·5°	
10	10·9	10%	1·050	[illegible]	[illegible]	[illegible]	1·07 ± 0·43°	0·460 ± 0·02°	2·60 ± 0·6°	
11	10·9	5%	1·017	[illegible]			3·00 ± 0·2°	1·12 ± 0·02°	2·16 ± 0·8°	

The small subscript figures are the deduction for contact resistance at the surfaces of the plate made from the two sets of observations and calculated from the formulae

$$\left.\begin{aligned} r_{\frac{1}{2}} &= x + y \\ r_{\frac{1}{4}} &= 2x + y \end{aligned}\right\} \therefore \; x = r_{\frac{1}{2}} - r_{\frac{1}{4}}.$$





Gasolene: Experiments :-

Tried the following experiment to see if the gas dissolved by water could be mechanically evolved by passage through gasolene.

A test-tube had a tube blown into its closed end as shown. The test-tube was fully filled with gasolene; i.e. from the shoulder to the dotted line AB. and water filled the rest of it, which it stood in a vessel of water up to about the level CD. A caoutchouc tube fixed on the lip at E allowed a water supply to be forced slowly in the direction of the arrow drop by drop through the tube and down through the gasolene. If any gas were disengaged it would thus be allowed to accumulate under the shoulder of the test-tube. No such gas was ever bubbled disengaged. Each drop took with it its self contained air.

Arrangements were therefore made to more finely subdivide the water in its passage through the gasolene, and the apparatus in fig 2 was used. The outer glass funnel was full of gasolene to the depth AB from the shoulder, and was submerged in water up to about the level EF, water being below the level AB. The small glass funnel was sealed into the neck of the large one and was closed at its mouth by a thin sheet of lead pierced with numerous pinholes so as to form a rose sprinkle. By means of a caoutchouc tube above, water was forced down through the gasolene. The water was not properly separated but was better divided than in the first experiment. Bubbles of gas did rise from the liquid above the layer AB. and after forcing through some 10 litres of water through the apparatus about 1·5 c.c. of gas collected in the shoulder. An attempt was made to test this gas as possible. A moist Pyro test showed no fall, but not sufficient

Meter Experiments contd :—

October 8th. Monday)

Collected 500 c.c. of 30% solution. sp. g. 1.158 @ 19.4°c by Hydr.
Added 250 c.c. of H_2O dest.
and obtained 750 c.c. of 20% solution.
sp. g. of 20% sol: 1.096 @ 20°c by balance
1.0965 @ 20.7°c - Hydr.

No. of obs.	Time	Plates	Bridge	Peak	Mn	corrected for leakage T.I.	for leakage F.I.	
		Temp						
1	11.27	½ 26.5°	100% 20.1°c	7400	1	0.461	0.31	
2	.30			710	10	0.30	0.28	
3	.37			130	50	0.315	0.30	
4	.39			.2	250	0.315	0.305	
5	.41	½ "		6400	1	0.57	0.57	
6	.42			670	10	0.59	0.58	
7	.43			100	50	0.59	0.57	
8	.45			0	250	0.58	0.57	
9	13.38	½ 51°		110	50	0.37	0.36	
10	.41	½ "		-	-	0.19	0.19	
11	.45	½ 45°		-	-	1.405	1.42	
12	.46	½ 45°		-	-	2.17	2.12	

Voltmeter Observations

1417 on Park circuit indicating 8 in excess
1416 - - - - correctly
1793 - Phonograph - - 3 in excess.

Phonograph Factory Blower Trials.

(October 8th Monday).

The motor at the Factory is so geared that when its armature makes 1000 revs per min, the line of shafting makes 200. Then the pulleys on the shaft for driving the blower being 38" diam those on the ~~intermediate~~ shaft 18" and 30" respectively, that on the blower 5½" we have for 200 revs. of shafting

$$200 \times \frac{38}{18} \times \frac{30}{5\frac{1}{2}} = 2300 \text{ revs. per min.}$$

The pipe connecting the cupola with the furnace is 9" in diam so that it has an area of 63.6 sq. in.

A shutter slide was arranged in a box fitted into the pipe so as to give a variable aperture. The breadth of the opening so made was measured and is given in the following series. The width of the shutter is so that an opening 5" wide corresponds to an aperture of sq. in.

Current in motor at. amperes	Estimated rotary speed at revs per min	H.P. absorbed by motor	Speed of blower r.p.m.	Width of shutter opening	Volume under maximum pressure	Pressure mm sq. in.
50	185	7.85	2650	closed	13"	7.53
65	"	9.17	"	1"	12½	7.24
75	"	10.58	"	2"	11"	6.37
80	"	11.28	"	3"	9⅝	5.36
93	"	13.11	"	4"	8"	4.63
95	"	13.40	"	5"	6⅞	3.98
110	"	15.51½	"	all open	–	

Record of blast pressures at Phonograph Works (2)
on the occasion of the first blast at casting.

No.	Time	Amplitude on standard	Estimated lbs absorbed by Meter	Slit	Mean pressure lbs per sq. yd. in chamber	Mean pressure in lbs per sq. yd. from Meter
1	12.43	62	8.74	open	7.8	7.82
2	.48	65	9.17		7.8	8.40
3	.50	64	9.02		7.8	8.45
4	.54	64	9.02		7.8	8.28
5	.57	63	8.88		7.7	8.28
6	13.00	61	8.60		7.7	8.28
7	.03	60	8.46		7.7	8.28
8	.06	59	8.32		7.7	8.22
9	.10	58	8.18		7.7	8.22
10	.13	58	8.18		7.6	8.22
11	.15	59	8.32		7.75	8.16
12	.18	62	8.74		7.5	8.04
13	.20	62	8.74		7.5	8.04
14	.25	62	8.74		7.8	8.51
15	.28	66	9.31		8.6	9.55
16	.30	65	9.02		9.2	9.55
17	.32	64	9.02		9.2	9.50
18	.36	64	9.02		9.1	9.50
19	.45	64	9.02		9.0	9.55
20	.48	64	9.02		9.0	9.55
21	.52	63	8.88		9.1	9.55
22	.55	62	8.74		9.1	9.50
23	.57	62	8.74		9.0	9.50
24	14.02	62	8.74		9.0	9.15
25	.05	70	8.87		8.0	9.55
26	.09	62	8.74		9.1	9.55
27	.14	63	8.88		9.1	9.55
28	.19	62	8.74		9.1	9.55
29	.25	63	8.88		9.1	9.50
30	.30	63	8.88		9.0	9.44

Meter Experiments cont

October 8th Monday

Took Resistance of the 4 12 lt + 25 lt batteries made up on the 7th inst. Kept a current of 1 ma passing through them in order to find how resistance fell.

No. of obs.	Time	Plates	Bridge	Res. in ohms	Ma	Deflections T.Z.	Deflections F.Z.	T.Z. per bottle
1	16·03	4 · 12 lt bottles Temp 21°C	1000 ~	7450	1	16·14	15·84	4·035
2	·10					16·23		4·06
3	·15					16·23		4·06
4	·20					16·23		4·06
5	·25					16·16		4·04
6	·30					16·16		4·04
7	·35					16·12		4·03
8	·40					16·08		4·02
9	·45					16·04		4·01
10	·50					16·02		4·01
11	·55					15·99		4·00
12	17·04					16·96		3·99
13	·05			100	50	11·16	10·74	2·79
14	·07			0	200	9·29	8·99	2·32
15	·10	4 25 lt bottles Temp 21°	1000 ~	6670	1	9·14	8·84	2·28
16	·15					9·29		2·32
17	·20					9·27		2·32
18	·25					9·23		2·31
19	·30					9·16		2·29
20	·35					9·14		2·29
21	·40					9·13		2·28
22	·45					9·09		2·27
23	·50					9·09		2·27
24	·52			100	50	6·29	6·04	1·67
25	·56			0	200	5·25	5·020	1·31

Motor Experiments contin.

October 9th Tuesday :—

Took 500 c.c. of the last or 20% $ZnSO_4$ solution whose sp. g. was found to be 1.100 @ 17°C by Hyde and added 500 c.c. of H_2O dist. to reduce it to 10% solution.

It then had a sp. gr. of 1.0515 @ 19.7°C by Hyde + 1.0468 @ 21.5°C - balance.

Took following measurements :—

No. of Ds	Time	Plate	Bridge	Res. in mf	Mac	cells for Time T.Z.	cells for Time F.Z.	
1	13.50	¼"	19.5	100 fm 19.4°C.	7400	1	2.99	2.69
2	·51				700	10	2.65	2.59
3	·52				100	50	1.93	1.86
4	·53				2	250	1.04	0.99
5	·56	½"			6200	1	1.04	1.02
6	·57				650	10	1.07	1.06
7	·58				100	50	1.07	1.04
8	·59				0	250	1.00	0.98
9	15.00	¼"	47.5		100	50	0.63	0.63
10	·58		46		100	50	2.66	2.59

One of the wires attached to the ½" zinc plate was found quite loose and this together with the obviously unreliable reading obtained from these plates rendered it necessary to dispense with them.

Collected 300 c.c. of this solution whose sp. g. was observed to be 1.055 @ 11.0°C by Hyde and added 300 c.c. of H_2O dist. to reduce it to 5% solution. The sp. g. was then by balance 1.017. In testing this solution, the polarization was very decided, but was certainly less at the higher than at the lower temperature.

Motor Experiments cont.

No.	Time	Plates	Bri.	Res.	Mag.	coll. for F.Z.	Rada. F.Z.	
1	16.22	½" 20°	100 fc. 2.6	7400	1	10.74	10.74	
2	.23			700	10	6.59	6.04	
3	.26			112	50	3.04	2.84	
4	.28			0	250	1.91	1.84	
5	17.20	47°		0	250	0.99	0.96	
6				100	50	1.03	0.96	
7				700	10	1.12	0.97	
8				7400	1	1.44	0.99	
9	18.03	5.8°		7400	1	7.74	7.74	
10				700	10	6.54	6.04	
11				100	50	3.16	3.01	
12				0	250	2.41	2.26	

Arc Experiments, made with Mr Wirt

October 10th Wednesday

Took two wires connecting 48 Edison lamps to the 111 volt circuit and obtained between them in air an arc of as much as 1" when the + wire was supposed to be above, and as much as ½" when the + wire was supposed to be below. ?

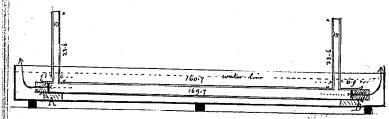
On pressing the ends of these two wires together on a fireclay cylinder and then drawing them apart, arcs 1" long were reached.

On pressing the ends similarly on a damp red brick, arcs ½" long were obtained.

On pressing the ends similarly on glass plate, arcs of over an inch perhaps ½ were obtained, the arc in each case fracturing the glass.

On pressing the ends similarly upon the glazed surface of a white clay fuse piece box, arcs of over one inch were obtained. The average being about one inch.

On removing the glaze at one side of the ring with an emery wheel + again) the unglazed smooth surface, superficially, the arcs obtained were as much as 3/16" the average being about ½".



Int. Diam.	at + mean A.	1·027" = 2·61 cms	Mean	5·350
" "	" B	1·076" = 2·73 "		5·854
			Mean	5·602
Ext. "	" A	1·206" = 3·06 "		
"	25 cms from outer of tube	1·213" = 3·08 "		
"	50 " "	1·222" = 3·10 "		
"	75 " "	1·235" = 3·14 "		
"	100 " "	1·229" = 3·12 "		
"	125 " "	1·226" = 3·11 "		
"	150 " "	1·252" = 3·18 "		

$$\frac{5.602}{169.7} = \frac{5.602}{1.697} \times 10^{-2} = 3.301 \times 10^{-2}$$

Meter Experiment contd:—

October 10th Wednesday

Made up the following apparatus to measure the sp. gr. of $ZnSO_4$ solution.

A glass tube 172·5 cms long and 2·61 cms in diam: cut at one end 2·73 cms at the other: had corks inserted into its ends. These corks were each faced with disks of zinc 2·5 cms in diam: and about 0·1 thick, connected to the measuring apparatus by rubber covered wires soldered to their backs which wires passed through the corks. Two smaller tubes were blown into the larger one at near the ends as shewn and they served for insertion of thermometers and for shaft to pour in and out the tested solution.

The whole tube was immersed in a zinc trough 182·5 long 10 broad + 10 deep of ⊔ cross section. This trough was filled with ~~the~~ water at the ordinary temperature, then with hot water and then with ice + water well stirred. The readings were taken when the thermometers at A and B were in accordance.

The small zinc disks were amalgamated before use.

Took the solution composed of 1337 grms $ZnSO_4$ salt + 1100 H_2O dist. and filtered it.

Its sp. g. was then by Beaumé Hydr 1·415 @ 18°C
" " Balance 1·396 @ 20°C.

The Two Thermometers were compared by setting them in the same vessel the Zero Therm. gave 19·3°
" 6° " " 19·6°.

Took the 50 gramme bottle which seemed to be a milligramme short of its empty) counterpoise and filled it with some of this solution. It gained 6 g.798 grammes @ 20°.c.

50 grammes of air at 20°.c weigh $\frac{273}{293} \times 50 \times 1.276$ grm $= \frac{273}{293} \times 638 = 59.4$ so that the weight of liquid would be 66.857 which exceeds 50 by 16.857 and ~~was 13.9~~ 13.9 which $= 1.3971$ = sp. g. 1.397.

Evaporated this liquid

Weight of evaporating dish 80.528

" " " " and anhydrous residue 103.05.

" " anhydrous In_2SO_4 evaporates 22.52 grm

There are therefore 22.52 grammes of anhydrous salt in solution of 27.48 grammes of water. As in evaporation some little explosion of bubbles took place with a slight scattering of salt there may have been more than this. 45.4 %

No	Time	Bridge	Nominal	Mass from tables	Mass. the tube	Corrected for tube T. Z.	Corrected for tube F Z	sp. v.	Temp A	Temp B
1	11.23	1000/1000 T.B 26°C	7000	1	0.9	6504.4	6487.7	21.44	21.6	21.6
2	.25		900	5	4.5	6509.9	650.5	21.5		
3	.26		50	10	.9	651.7	651.2	21.5		
4	.27		0	10.5	9.6	652.6	652.1	21.52		
5	.28		7000	1	0.9	654.7	652.7	21.54		
6	13.42		0	16	14.5	353.7	353.7	11.44	49.2	49.0
7	43		7000	1	0.9	359.7	357.7	11.80		
8	14.25	1000/1000	7000	1	0.5	1141.7	1139.7	37.61	56.6	56.2
9	.26		450	5	2.5	1145.7	1145.7	37.82		
10	.26		0	7	3.5	1145.7	1145.7	37.82		
11	.45		0	7	3.5	1029.7	1029.7	33.96	49.8	50
12	15.14	1000/1000	0	10	9.8	835.7	835.7	27.56	48.3	48.2
13	16.42		0	10	9.1	759.7	749.7	24.74	47.6	47.8

$\frac{5.677}{1697}$ .3227

Assuming that

$$a + bt + ct^2 = \rho$$

$$a = +43.15$$

$$b = -1.323$$

$$c = +0.0138$$

Meter Experiments contd.

October 10th Wednesday

Took the resistance of two samples of iron wire bought by M Wirt.

A The first was 577 cms long and #20 0.035" = 0.0889 cm

B - second 433 - - #27 0.016" = 0.0406 cm

The area of the 1st (A) wire thus 6.207×10^{-3}

2nd (B) - 1.295×10^{-3}

The resistances were

	Res.	Leads	corrd.	Temp.	Sp. r.
A	~~1.235~~ 1.235	0.220	1.015	20°C.	1.092×10^{-5}
	~~1.224~~ 1.204	0.220	0.984	11.1°	1.059×10^{-5}
	~~1.224~~ 1.275	0.220	1.055	30°	1.135×10^{-5}
B	4.870	0.220	4.650	20°C.	1.395×10^{-5}
	4.524	0.220	4.304	11.5°C	1.291×10^{-5}
	5.090	0.220	4.870	30°C.	1.461×10^{-5}

$$\frac{6.207 \times 10^{-3}}{5.77 \times 10^{2}} = 1.076 \times 10^{-5}$$

$$\frac{1.295 \times 10^{-3}}{4.33 \times 10^{2}} = 3 \times 10^{-6}$$

∴ A's coefficient

	Change between		Diff. Temp.	% resistance	% per °C
	11.1 + 20°		8.9°		
	0.031	in	8.9°	3.15	0.354
Between 20+30	0.040	in	10°	3.94	0.394
	11.1 + 30	0.071	18.9°	7.21	0.382

B's coefficient

Between	11.1 + 20				
	0.346	in	8.5°	8.04	0.945
	0.220	in	10°	4.73	0.473
	0.566	in	18.5	13.15	0.716

A was supposed to be nearly pure iron but a little brittle

Specific Gravity Measurements :—

October 11th Thursday

Took a solution (nearly) concentrated) of $ZnSO_4$ in H_2O dist. + compared the readings of three different sp. g. instruments in it, as follows :—

No. of Test	Sp. g. by balance	Temp. solution	Sp. g. by Beaume	Error of Beaume	Sp. g. by Hydr.	Error of Sp. g. Hydr.	
1	1.418	23.3°	—	—	1.41	− 0.008	
2	1.310	23.8°	1.355	+ 0.045	1.30	− 0.010	
3	1.195	23.5°	1.245	+ 0.050	1.180	− 0.015	
4	1.171	24°	1.205	+ 0.034	1.160	− 0.011	
5	1.120	23.5°	1.150	+ 0.030	1.120	− 0.000	
6	1.091	23.3°	1.120	+ 0.029	1.090	− 0.001	
7	1.061	23.1°	1.080	+ 0.019	1.060	− 0.001	
8	1.031	22.5°	1.040	+ 0.009	1.030	− 0.001	

From these results the errors of the Hydrometers are

Greiner Aerometer		Greiner Cmp. Hydr.	
Between sp. g. as indicated by inst.	Error	Between sp. g. as indicated by inst.	Error
1.000 and 1.050	+ 0.010	1.000 and 1.120	− 0.001
1.050 " 1.080	+ 0.015	1.120 " 1.41	− 0.010
1.080 " 1.150	+ 0.025		
1.150 " 1.200	+ 0.030		
1.200 " 1.250	+ 0.040		
1.250 " 1.350	+ 0.045		

Contents of tube

p 1	g 26	3.5	12.25	12.25
" 2	g 30	0.5	0.25	0.50
" 2	g 32.5	3.0	9.0	18.0
	88.5			Σ p² 30.75
	g 29.5			

$$0.67645\sqrt{\frac{30.75}{2}} = 0.67645\sqrt{30.75} = 0.67645 \times 5.54$$

$= 2.6642$ P.Er. of Ob. wt 1.

P.E of Mean $= \frac{2.6642}{\sqrt{8}} = 1.18$

Meter Measurement:—
October 11th Thursday

Took two specific resistance measurements with the long tube, the first with corks in the ends as in "the trial recorded on page 31. It was found however that these corks did not keep perfectly watertight, although the resistance was not affected, troublesome loss of solution occurred. In the second experiment therefore the corks were replaced by rubber stoppers with hole pierced admitting the rubber covered wire tightly. No further trouble on the score of leakage was then appreciated.

The sp.g. of the orig. sol. was 1.396 by Balance @ 20°C
" " " " " 1.397 by sp. g. bottle.

This corresponds to 55% solution by tables. and its composition (137 gms $ZnSO_4$ to 100 H_2O) makes the amount 54.96%

Collected of this solution 990 c.c. of sp.g. 1.396. of which 49 g would presumably be $ZnSO_4$

Added 100 c.c. of H_2O making the total 1000 c.c. and reducing the % of salt to 49.5 or 90% of orig. strength. The sp. g. of this solution after filtering was 1.360 by Balance @ 20.5°C.
1.385 " Hydr. @ 19.1°C calc = 1.3440

Collected of this solution 920 c.c. of sp.g. 1.3820 = 1405 gs of which 45 g. 4 c.c. were presumably $ZnSO_4$ added 1240 c.c. of H_2O dist. making 1014 c.c. or a 44.6% solution. 80% of original strength. The sp.g. of this after filtration was { 1.318 @ 24.°C by Balance
1.355 @ 16.2°C by Hydr. = 1.3140

The tube when filled with rubber stoppers was observed to hold up to the base of the shafts 929 c.c. @ 19.1°C

Inter Electrode dist. 16 g.0
Clearance .5
16 g.5

929.5 ÷ 16 g.5 = 5.4844 top volume
5.602 bottom
5.5443

$\frac{A \times 5.5443}{16 g.0} = 0.0328$ A $= 3.28 \times 10^{-2}$

$\frac{5477}{16 g.} = .3241$

From the 90°F. values
a = +37.75
b = −1.089
c = + 0.0118

Assuming that $a + bt + ct^2 = \rho$
we have
a = + 35.22
b = − 0.903
c = + 0.00795

Meter Experiments contd. —

October 11th Thursday.

Took following readings on the columns of solution 90°F. 80°F. orig. strength mentioned on preceding page. Twice electrodes freshly amalgamated

No. of Obs.	Time	Solution temp	Resistance est.	Mass for letting	Mass to tube	I X calc for tube 0.36	F.X.	5.444 of mass
1	10.20	90°F 19°	6900	1	0.9	658.7	657.7	21.64
2	.31		900	5	4.45	658.4	657.7	-
3	.32		50	10	9.1	658.5	657.7	-
4	11.00	A 45.5 45.2 B	0	10.7	9.8	354.4	354.4	11.64
5.	.45	5.0 5.8	0	10.7	9.8	994.7	993.7	32.41
1	15.10	80°F A 18.2 18.6	7800	1	0.9	660.7	659.7	21.64
2	.12		900	5	4.45	658.7	658.2	21.59
3	.14		0	10	9.1	657.8	657.2	21.30
4	.45	45.6 45.0	0	10	9.1	359.2	359.2	11.64
5	15.48	4.3 4.8	0	10	9.1	963.7	963.7	31.623

For the case of the last solution took the expansion of the liquid.

Meter Experiments —
October 11th Thursday.

By observation following is calibration of upright shaft tubes

Vol: liquid poured in about two filling	Diff	Height of in A	Meniscus in B.	Reading in A	in B.	Mean	cc per cm
30 cc.	30	4·9	5·1	4·9	5·1	5·0	6·0
61	31	10·8	11·2	5·9	6·1	6·0	5·16
88·5	27·5	15·6	16·0	4·8	4·8	4·8	5·73
127·5	39	22·65	23·2	7·05	7·2	7·13	5·47

Mean of last 3 = 5·445

The range between 4·5·3° C and 4·6°C. = 40·7° produced a difference of 5·8 cmc (sum of both legs) = 5·8 × 5·445 = 31·61 cc. in 9 2934 5·3·5 at lower temp = 983 cc. = 3·22% equivalent to about the range in H_2O between 4° + 85° or 81° C.

3·22 ÷ 40·7 = 0·0791 % per·c.

Meter Experiments
Specific Res: + temp. Coefficient of iron wire
October 12th Friday.

Coil No	Length	Drain limited	Drain outward	Res at 14°	Res at 20°	Res at 54°	Coeff: for 14–20°	Coeff per°
I	1398·5	0·0209 0·0247	0·0147 0·0254	22·945	25·090	28·270	4·78	0·797
II	1559	0·0267 0·0160	0·0254 0·0105	26·665	27·960	31·99	4·86	0·81
	Coeff for 20–54°	coeff per 20–54°	Coeff for 14–51°	Coeff per 14–51°	Res at 0 0°C	Area sq. mm	Area / Length	Sp. r.
I	12·67	0·409	19·06	0·488	22·42	65×10⁻⁶	5·62×10⁻⁶ / 1398·5 = 4·02×10⁻³	8·97×10⁻⁶
II	14·41	0·465	19·97	0·540	24·78	5·6×10⁻⁶	5·6×10⁻⁶ / 1559 = 3·59×10⁻³	8·92×10⁻⁶

Motor Experiments contd.

October 12th Friday

The coils of iron (tinned) wire whose coeff. for temp. and p.p. res were observed & recorded on preceding page were obtained from a reel given me by Mr Watt. The measurement were taken electrically by Self and mechanically by Boynton.

Revision of figures relating to the capacity of long tube.

1st measurement	Hennelly + Bugh	921	c.c.
2nd "	Boynton	920	"
3rd "	"	921	"
		Mean 920.7	"

Collected 992 c.c. of the last 80% solution or 44.7% $ZnSO_4$ and as 436.5 of this were supposed to be $ZnSO_4$ added 142 c.c. making 1134 c.c. of assumed 70% or 38.5% $ZnSO_4$ whose density @ 20°C by the bottle is giving at 1.255

The density of this solution after filtration was observed to be 1.320 @ 16.1°C by Hydr. Beam
1.283 @ 16.1 " " balance

The density before the addition of water was 1.355 @ 15.7° by Aquam Hydr.

The distance between the electrodes in the tube after reamalgamating and resetting them was 168.3 cms.

The amount of liquid poured into the tube was 972.5 c.c.

The mean area of the column between the disks taking its volume at 920 c.c. would be

$\frac{168.3}{1728} = \frac{920}{168.3} = 5.467$ sq. cms

The height of the columns at the different temps. were :— at A ~~6.6~~ ~~16.6~~ cms temp. 17. A 9.4
B ~~6.8~~ ~~16.8~~ ~~9.4~~ B 9.5 19.3
A ~~5.6~~ ~~15.6~~ 51.6 A 11.7
B ~~15.7~~ ~~23.4~~ B 11.7 23.4 / 3.5
Rise 14

$\frac{23.4}{3.5} \times 5.45 = 19.3$ c.c. 19.5 in 972.5 = 1.96%
in 34.6° = 0.0567 % per °c. equivalent to water expansion between 4° & 65° : 61°
This result rendered unreliable through subsequent stiffe leakage.
From the 70% series. a = +35.88
b = −1.023
c = +0.01014

$\frac{5.477}{16.3} = 3.254$

The height of the columns were

Temp	A	B	A+B	Diff	%	% per°	
18.5	4.3	5.65	9.95				Thermometer lifted by mistake in tube
48.5 } 43	6.5	7.8	14.3	4.35	2.1448	0.081	
				1.15	0.6646	0.058	
71.5 } 66	3.8	5.0	8.8	5.5	2.698	0.075	Thermometer lifted into shape

8.8 × 5.45 = 47.96 say 48 + 921 = 970 cms.

4.35 × 5.45 = 23.71
1.15 × 5.45 = 6.27
5.5 × 5.45 = 30.0

From this series
a = +35.13
b = −0.92
c = +0.0089

Meter Experiments cont'd :—

No. of Obs.	Time	Solution & temp	Res. in calt.	Mass the battery	Mass the tube	T. Z. calt for load	F.Z. calt for load	Diff.
1	10.25	70% A 16.7 B 16.7	6700	·1	0.9	662.9	662.9	×100
2	·26		800	5	4.5	662.8	662.7	
3	·27		0	10.5	9.6	663.0	662.9	21.5%
4	·46	A 51.6 B 51.6	0	10.5	9.6	332.7	332.7	10.83
5	·50	A 61.6 B 61.2	0	10.5	9.5	912.8	914.5	29.76
6	·51		7000	1	0.9	914.8	914.5	

Collected 1000 c.c. of this 70% solution or 38.5% $ZnSO_4$ and ~~forwarded~~ as it was assumed to contain 385 c.c. of $ZnSO_4.7H_2O$ added 167 c.c. which presumably reduced it to 60% only solution or 33% $ZnSO_4.7H_2O$ which by tables should have a density @ 20°C of 1.313 It was observed to have a density of 1.2413 0.2270 by volume after filtration.

The tube was in those following heat employed without altering the position of the electrodes or remamalgamation of their surfaces.

No. of Obs.	Time	Solution & temp	Res. in calt.	Mass the battery	Mass the tube	T. Z. calt for load	F.Z. calt for load	Diff.
1	14.11	60% A 11.7 B 11.7	7000	7.0	0.9	654.7	654.7	
2	·15		900	5	4.5	653.5	653.3	
3	·16		0	10	9.6	653.0	652.9	
4	·18	A 16.6 B 16.6	0	10	9.6	650.7	650.6	21.1%
5	·43	A 43.7 B 43.3	0	10	9.6	354.7	354.7	11.54
6	15.53	A 60.7 B 60.7	0	10	9.6	889.7	889.3	28.9 d.

$\frac{5.467}{16.3} = 3.249 \times 10^{-2}$

Assuming that $a + bt + ct^2 = \rho$

we have

$$a + 5.2t + 27.0t^2 = 33.01$$
$$a + 19.8t + 392.04t^2 = 21.62$$
$$a + 48.8t + 2381.44t^2 = 12.88$$

whence

$$a = +38.11$$
$$b = -1.035$$
$$c = +0.0102$$

Meter Experiments cont.

October 14th Saturday)

Recovered 1000 c.c. of the last 60% solution & observed it to have a density of 1.280 @ 17.6°C by Hydrometer. As it was assumed to contain 330 c.c. of $ZnSO_4$ added 200 c.c. making 1200 c.c. of dilution assumed to have 27.5% of $ZnSO_4 + 7H_2O$ which by tables has a density of 1.172 @ 20°C.

The observed density was 1.203 @ 21.0 by balance
1.245 @ 19.1°C - Reammi Hyd

The distances between the disks after remagnetization was observed to be 167.4 cms.

The observed contents of the tube up to the base of the shaft was 918 cc. this displaced 167.4 = 5.484

No. of obs.	Time	Solution & temp.	Res. in 10^{-6} ohms 20°C	Max. Res. in the tube	Max. Res. tube	T.Z. off for tube	FZ off for tube	cf. r.
1.	10.15	60% S 19.7 B 19.7	7000	1	0.9	660.9	660.9	
2	.16		900	5	4.5	661.0	660.7	
3	.17		0	10	9.7	660.3	660.6	21.62
4	.50	A 26.6 B 19.0	0	10	9.1	393.6	393.6	12.88
5	11.42	A 5.0 B 5.0	0	70	39.5	100 ~~f~~ 2	100 ~~f~~ 2	33.01

Expansion of liquid.

No. of obs.	Time	Mean temp	Height in A	Height in B	Sum A+B	Diff	Diff temp	Diff for 1°C change	Diff for 1°C change
1	11.42	5.1	7.4	7.5	14.9				
2	10.15	19.8	8.15	8.10	16.25	1.35	14.7	0.736	0.050
3	10.50	48.8	10.35	10.35	20.7	3.45	29.0	2.420	0.084
						5.80	43.7	3.162	0.073

1.35 × 5.48 = 7.36 ÷ 918 + 5.48 × 18 = 52 = 1000
4.45 × 5.48 = 24.4 ÷ 918
5.80 × 5.48 = 31.8 ÷ 918

Experiment cont. –

Oct. 12th Saturday

Temp. of meter bottle under heat –

		Hot	Meter		Cool meter
Oct. 12th	17.45				
		Shunt 60·5	62·2	Bulb 25	27·2
13th	15·00	60·5	62·2		30·0

Wt. of transformer armature after the two coils (new) connected up in gramme ring fashion and soldered.

Insulation between two coil about 8000 = 4 8500 =

Res. of fine wire coil 43·50 but 0·480 = 43·980

= 172·8 ω in all

– coarse – 1·226 – 0·43 = 0·796 ω

= 3·984 ω in all

Dividing these by 36 we have as the future total res. of the machine excluding self induction + connecting wires

coarse wire circuit 4·80 ω

fine wire coil 0·083 ω

Phonograph Batteries.

October 17th Saturday.

German Chromic acid having been substituted for American chromic acid in the phonograph cells, & complaints about their energy having since been made the following tests were made to investigate the cause of failure.

The solutions made up were :-

No. Acid		Un. Formula	Actual Quantities used	Weight of the plate	Initial EMF	Current after 1 hour	Length of time shown in curve
1	Gr. Chromic Acid Solution & Water	5 10 25	8 g. 270 c.c. 1135 c.c.	415	2·012	2·688	5 hours
2	Gr. Chr. Ac. H_2SO_4 H_2O	5 15 25	7·2 g 336 c.c. 1021 c.c.	392	2·028	1·544	0·8
3	Gr. Chr. Ac. H_2SO_4 H_2O	7·5 10 25	11·3 g 234 c.c. 1066 c.c.	407	2·006	3·040	7·50
4	Gr. Chr. Ac. H_2SO_4 H_2O	7·5 15 25	10·1 g 314 c.c. 953 c.c.	377	2·076	1·736	3·4
5	Gr. Chr. Ac. H_2SO_4 H_2O	10 18 25	14·1 g 219 c.c. 997 c.c.	404	2·056	3·104	9·0
6	Gr. Chr. Ac. H_2SO_4 H_2O	10 15 25	12·8 g 299 c.c. 907 c.c.	412	2·104	2·464	8·0
7	Gr. Chr. Ac. H_2SO_4 H_2O	7·5 15 20	9·7 g 299 c.c. 799 c.c.	405	2·040.	2·552	5·5

The cells were started each in 0·5 platinoid element at 8·15 and the accompanying curve is the plot of the observations.

Meter Experiment cont:-

October 16th Sunday:-
Took down hot and cool meter, dried and weighed plates:-

Met. No	Weight 4.10.95		Joint Weight + Cover	Weight 10.15	Joint Wt Weight Prism.	Gain	Loss.	M
1	87.88	39	174.3983	87.3964	175.4558 / 174.4356	0.5513		
2	87.55	24	174.3975 +0.0008	87.0392	0.0000 +0.0181		0.5132	
3	90.05	82	178.0907	90.6044	178.1323	0.5762		
4	88.03	12	178.0994 + 0.0013	87.5286	178.1320 −0.0007 +0.0436		0.5026	
5	91.70	28	182.0906	92.2256	182.1173	0.5228		
6	90.38	75	182.0906 0.0000	89.8927	182.1183 +0.0010 +0.0277		0.4951	
7	87.88	69	175.8552	88.3368	175.9466	0.4499		
8	87.96	93	175.8562 −0.0010	87.6107	175.9475 −0.0007 +0.0913		0.3586	

As there was some glaring discrepancy in these results, Mr Wirt tested the hot meter on Oct. 16th Monday & found the res. of

The left hand dials of pol. & shunt before endowing of the screws 8.51 after 8.17
" right " " " " " " " " 9.36 " 8.24

Thus showing that bad contact had been made at these screws, and that consequently all the results hitherto collected on these two meters are unreliable

$0.174 \times 8.5 = 1.5$ grs per cm
3000 cm $= 4500$ grs $= 9.0$ lbs roughly.

Calculation for the dimensions of a platinoid strip that shall serve in a standard meter and which shall consequently not rise in temp. on 10°C when carrying a current of 20 amperes.

If the strip have a width of w
a thickness of t
a spec. res. of ρ
a traversing current c

Then the res. of the strip will be per linear cm

$$\frac{\rho}{tw}$$

and the energy expended in traversing it per cm

$$\frac{c^2\rho}{tw}$$

the heat units (therms) generated per sec.

$$\frac{c^2\rho}{4.2tw \times 10^7}$$

The surface of the strip $= 2w$ per neglecting the edges and the radiation in therms per sec.

$$= \frac{2\theta w \times 2 \times 10^{-4}}{}$$

$$\therefore c^2\rho = 16.8\, tw^2\theta \times 10^3$$

$$\therefore tw^2 = \frac{c^2\rho \times 10^{-3}}{16.8\,\theta}$$

Here $c = 2$ $\rho = 4.03 \times 10^{-6}$ $\theta = 10$

$$\therefore tw^2 = \frac{16.12 \times 10}{16.8 \times 10} = 0.96$$

If we make w the present width i.e. 5.5 cm

$$t = \frac{0.96}{30.25} = \frac{9.6 \times 10^{-1}}{3.025 \times 10^1} = 3.17 \times 10^{-2} = 0.0317$$
$$= 0.125''$$

If made 5.5 cm wide the sectional area would be
$3.17 \times 10^{-2} \times 5.5$ or $17.44 \times 10^{-2} = 1.744 \times 10^{-1}$ sq. cm per cm.
$= \frac{4.03 \times 10^{-6}}{1.744 \times 10^{-1}} = 2.316 \times 10^{-5}$ ohs per cm $= 2.316 \times 10^{-4}$ ohs for 0.1 m we require
$\frac{4.03 \times 10^{-6}}{3.1415 \times 10^{-1}} = 0.0128 \times 10^{-5} = 1.28 \times 10^{-4}$ $= 4.32 \times 10^{-4} = 0.43$ ohs.

$\frac{908}{167.5} = 5.420$

$\frac{5477}{167.5} = 327$

Meter Experiments cont'd :—

October 16th Monday.

Collected 1000 c.c. of the last or 50% solution assumed 27.5% $ZnSO_4 + 7H_2O$, and observed its sp. g. to be 1.245 by Beaumé Hydr. @ 19.0° C., and added 250 c.c. of H_2O dist. to obtain 40% sol: or 22% $ZnSO_4 + 7H_2O$. The sp. gr. of this solution is by table 1.136 @ 20°.0. After filtration the diluted solution was 1.1659 @ 22°.0 by balance 1.205 @ 18.1°. Hyd. B.

Took the following tests.

Dist: between amalgamated electrodes 167.5 c.

Capacity of tube 908 c.c.

No.	Time	Solution strength	Resist.	Mins. for testing	Mins. flow tube	Volt for F.Z.	Volt +3 F.Z.	Sp.
1	14.05	40% A 19.1 B 14.4	7000	1	0.9	753.7	753.3	24.4
2	.07		800	5	4.5	746.0	745.7	24.2
3	.08	T.B. 24.6	0	10	9.1	744.0	744.0	24.33
4	.36	A 50.6 B 51.3	0	10	9.1	433.3	433.2	14.16
5	15.40	A 0.7 B 5.6	7010	4	0.5	1143.7	1133.7	36.7
			0	12	6.0	1074.7	1074.7	35.15

Expansion observations

No.	Time	Mean Temp.	Height A	Height B	Sum	Diff. Diff.	Diff. Diff. Temp.	% Change	Temp. per 10
1	15.40	4.9	7.0	7.7	14.7				
2	14.05	19.2	7.6	8.3	15.9				
3	14.36	51.2	10.0	10.7	21.7				

Multipolar Dynamo Experiment.
October 16th Monday

Ran New octopolar Dynamo with :—
The eight magnet coils on each side in series and the two sets then in parallel on the 110 volts circuit

The current in the fields was then 12 ampere 6 on each side and the voltage at the terminals 91 speed being a little under 800 rev. per min.
Ran at this rate and under this field, but without supplying current from 11.10 to 13.0
The temp. shewn by a thermometer laid on the armature periphery and covered by waste was 140°F.

To increase the voltage connected the magnets in four sets of four each.

The current being then 40 ampere obtained 130v
= 10 ampere per coil
and at 31 ampere obtained 112
7.75 " per coil
the speed steady at 792.
On exciting the field from the #8 machine at full potential with the magnets in two rows of eight, reached 130 volts at 18 ampere or 9 per coil.
The highest armature temperature reached was after two hours run 17.0 = 165°F

Calculation for the length and carrying capacity of a line of iron rods.

The length of each rod is about 10·6" or 320 cms
- diam. - - - - 0·5" or 1·27 cm.
- area - - - - - 0·1964 □" = 1·267 □cm
- measured res. - - - - 3·0 × 10⁻⁵ at 20°C.
- sp. res. then being $\frac{3.0 \times 10^{-5} \times 1.27}{320 \times 10^{2}} = 1.19 \times 10^{-10}$

The heat units generated by a current of strength c per linear cm. will be $\frac{c^2 \times 1.19 \times 10^{-10}}{1.27}$ per sec. $= \frac{c^2 \times 9.37 \times 10^{-8}}{4.2 \times 10^{7}} = 2.23\, c^2 \times 10^{-16}$

The thermal radiated

$$= 1.27 \times 3.14 \times \theta \times 2.8 \times 10^{-5}$$
$$= 7.97\, \theta \times 10^{-4}$$

$$\therefore \theta = \frac{2.23\, c^2 \times 10^{-16}}{7.97 \times 10^{-4}} = \frac{22.3\, c^2 \times 10^{-16}}{7.97} = 2.80\, c^2 \times 10^{-13} = 0.280$$

for 1000 ampere $c^2 = 10000 \quad 10 \times 10^{6}$

$$\theta = 3 \times 10^{-3}$$

for 800 - $c^2 = 64000 \quad \theta = 179.0°$ C.

- 500 - $c^2 = 2500 \quad \theta = 700°$ C.

180 feet of rod with having initially a temp. of 20° would have res. of $1.80 \times 10^{2} \times 3.05 \times 10^{-5} \times 9.37 \times 10^{-8} = 5.1444 \times 10^{-2}$ ω neglecting the res. of joints, so that the current initially would be merely

$$\frac{120}{0.051} = 2400 \text{ amperes.}$$

at 700° C. the res. will have risen at least 300% (300×0.5) making the res. 0.20 and limiting the current to 600 amperes.

Meter Experiments. cont.

October 12th Friday

Measurement by Mr Wirt of the mag. of the 25th meter bottle in series set up Oct. 5th

No.	Time.	Time elapsed since starting over cell for lads, reduced to hours	Reg. Measured cell for lads, reduced to amps	Bridge no.	Temp.
1	10·10	0	9·0	1000/100 1 mag.	22·0
2	·30	20	7·8	Lead 0·24	
3	11·00	50	6·5		
4	11·15	1·05	5·9		
5	11·35	1·25	5·4		
6	11·45	1·35	5·1		
7	13·35	3·25	4·2		24·0
8	13·45	3·35	4·1		21·80
9	14·00	3·50	4·1		
10	14·15	4·05	3·9		
11	14·55	4·45	3·9		
12	15·15	5·05	4·0		24·
13	15·35	5·25	4·0		

$\frac{5477}{167.4} = .13272$

Assuming that we have

$$a + bt + ct^2 = f$$
$$a + 14.9t + 24.01t^2 = 35.82$$
$$a + 19.3t + 372.5t^2 = 24.34$$
$$a + 51.2t + 2621.4t^2 = 14.18$$

Whence

a	$= +40.76$	1.047
b	$= -1.052$	1.076
c	$= +0.01014$	1.134

Meter Experiments contd :— (29)

October 18th Monday.

Collected 1000 c.c. of the last or 50% solution. (27% alt.) of density 1.2148 @ 19°.0 C. and added 2501 c.c. H_2O dist. to obtain 1250 c.c. of 40% solution (22% salt.) which by table has a density of 1.1355, and was observed to be 1.1659 @ 22.0 C by balance or 1.205 @ 18.1°.0 C hydrometer.

Distance of electrodes apart 167.4 cms

No of Obs.	Time	Solution Temp	Resistance est.	Mins the battery	Mins the tube	Bridge set	T.Z. calc. for tube 02	F.Z. tube 02	f.r.
1	14.00	19.1 A 19.1 B 19.0	7000	1	0.9	1000 from	702.7	753.3	
2	.02		800	5	4.5	58.2	746.2	745.7	
3	.03		0	10	9.1		746.0	746.0	24.34
4	.05								
5	.36	19.95 B 21.8	0	10	9.1		433.3	433.2	14.18
6	15.40	19.7 B 6.3	7000	10	9.0	1000 from	1133.7	1133.7	
7			0	12	6.0		1095.7	1094.7	35.82

No of Obs.	Time	Height of mercury A	B	Sum	Mean temp	Diff. bulb	Diff. bulb. stem	Diff. bulb.	
1	14.0	7.6	9.3	14.9	19.3	14.4	2.2		
2	14.40	10.0	10.7	20.7	5.62	{34.9 / 46.3}	{3.8 / 6.0}		
3	15.40	7.0	7.7	14.7	4.9		0.0		

Octofular: Dynamo Tests.

October 16th Tuesday.

Commenced running at 12.55

Charged field May 2 sets of 8 from 107 volts P.D. 92 volts

" " 175 " " " " 181 " " 123 "

Revs. 783

Noon shut down for lunch air 80°F

after 1st 5' 110°

10' 128°

12.10 Commenced running P.D. 119. 16.5 amp. Field

.55 stopped air 79°F

5' 172

10' 183.

13.05 Started. 16 ampère 119 volts

.55 stopped air 81°F

5' 173°

10' 190°

14.05 Started 16 ampère 119 volt

.55 stopped air 80°F

5' 170

10' 182

15.05 Started 16 ampère 118 volts

.55 Stopped air 76°

5' 164°

10' 178°

16.05 Started 16 ampère 123 volts speed 800 revs.

.55 Stopped air 80°

5' 179°

10' 192° (Thermometer touching bend)

17.05 Started 16 ampère 123 volts

18.00 Stopped air 80°

5' 124°

10' 150°

18.10 Started 16 ampère 123 volts

19.00 Stopped air 70°. 5' 156° 10' 176°

.10 Started 16 ampère 124 volts

21.10 Stopped air. 70° 25' 182°

5' 167° 30'. 182°

10' 180°

15' 182°

20' 184°

(Phonograph Battery) Tests
(October 16th Tues day)

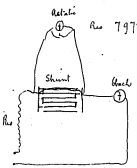
3 cells of 2 quart size were made up with 8% Zinc plates and the usual formula 7.5 parts Am. chromic acid 15 parts H_2SO_4 comm. + 40 H_2O. They were worked through the day upon 0.5 ω and are in every respect comparable with those based on the 18th with Germain Chromic acid. The curves are shewn on the opposite page. Whereas the longest lifetime above 2 ampères was 9 hours with the Ger. Chr. acid it was now than 13 with the American.

Heat data.

Mr Wirt supplied following information concerning the heating of wire

60 Watt per sq in (i.e. 9.263 Watt per sq cm) produces full red heat in

10 - - - - (i.e. 1.55 Watt per sq cm) melts him.



			microhms
Res. of	1 strip shunt	0.00138 ± 6.00000043	1380 ± 43
"	" Check "	0.000197 ± 0.000000006	197 ± 6
"	2 " in parallel	0.000098 ± 0.000003	985 ± 3
"	3 " "	0.000065	657
"	4 " "	0.000049	49.3
"	5 " "	0.000039	39.4
"	6 " "	0.000032	32.8
"	7 " "	0.000028	28.1
"	8 " "	0.000024	24.7

Tests and Calculations of the 1000 Ampere Shunt.

52

Each connection is made up of 23⅝" length of platinoid strip ⅛" thick and 2¼" wide.
Or in cms. 60 long × 60·96 × 0·159 thick
The area is thus 60·96 × 0·159 = 9·692 sq. cms
and the res: of the whole connection is thus assumed to be $\frac{4.032 \times 10^{-6} \times 60}{9.692} = 2.496 \times 10^{-6}$
$= 25 \times 10^{-5}$ ω. ∴ 250 microhms × 7·9 = 1·975 microhms = 0·00175 in ω
The P.D. on the machine terminal on the passage of an current of c ampere = $2.5 \times 10^{-6} \times C$ volt
where n is the number of plates in parallel
40 amperes traversing one plate would therefore produce ½ of a volt. or if all the plate were in series it would give 0·07 volt

Joined up the shunt with the Check Galvo and platinoid resistance board. Results as follows:-

No. of Obs	Check Defl.	Current to Main	Defl. on Galvo	Constant of Galvo	Value of one div. in ohms	Corresponding current in Galvo	P.D. on shunt ohm value	Res. of shunt ohm value	Calculated value
1	+1·02	0.5·06	+31·0	1 ohm at 1 div.	0.45×10^{-3} / 2·165	9.96×10^{-3}	1.37×10^{-6}	1.46×10^{-6}	1.75×10^{-6}
2	+1·02	0.5·06	−32·0	@ 71·1° Mod. 20000		230·0	7.61×10^{-6}	1.50×10^{-6}	
3	+1·74	0.9.67	55·5	+Galvo = 2·16	3.15×10^{-3}	$17.00 \times$	13.2×10^{-6}	1.37×10^{-6}	
4	+1·72	0.9.61	53.	+2·17		$17.00 \times$	12.6×10^{-6}	1.31×10^{-6}	
5	+0·33	1·93	10·0	20·7 = 23·5C		$\frac{232}{1.37}$ =		2.38×10^{-6}	1.30×10^{-6}
6	−0.33	1·93	10·25	+ 1·27 = 1.237 × 20·5 =		$\frac{232}{1.37}$ =	2.40×10^{-6}	1.33×10^{-6}	
							Sum	2.37 / 1.38	

No. of Obs	Res. of Shunt deduced	Mean	v	v²	Σv²	Σv²/(n(n−1))	Value probable mean
1	1.46×10^{-6}	1.38	0.08	0.0064	0.03247	0.00027	1.38 ± 0.016
2	1.50		0.12	0.01424			
3	1.37		0.01	0.0004			
4	1.31		0.07	0.00449			
5	1.30		0.08	0.0064			
6	1.33		0.05	0.0025			

$\frac{5.477}{167.3} = 3.274$

Assuming that we have

$a + bt + ct^2 = \rho$

$a + 6t + 36c = 39.5$

$a + 16.6b + 275.6c = 29.6$

$a + 51.5b + 2652.3c = 16.2$

whence

$a = +46.3$ 1.10

$b = -1.207$ 1.23

$c = +0.0125$ 1.32

$5.45 \times 2.1 = 114.5$

$\underline{952.5}$

$1022.$ @ 6.0°C. } 45.5°C.

and 35.424 @ 51.5°C

$= 3.395$ for 45.5°C

$\cdot 0426$ " $\therefore$ 90.

Meter Test contd.

October 16th Tuesday.

Collected 1000 c.c. of the last or 40% sol. (22% wt.) of observed density 1.167 @ 14.6°C and added 333 cc. of H_2O dist. to produce 1333 c.c. of 30% solution (16.5% wt.) which by bottle has a density at 20°C of 1.100, and was observed to have a density of 1.128 by balance @ 19°C.

or 1.127 " Hydr. @ 15.3°C.

Electricity 167.3 cms after

No.	Time	Temp. solution	Bridge	Res. in cot	Mean Res. battery	Mean to tube	TX cold	FX hinds 0.3	sp. r.
1	9.47	24° & 16° 8.68	100/100	7000	1	0.91	914.7	913.7	29.91
2	.50		78.17	600	5	4.5	907.7	906.7	29.69
3	.52			0	8	7.3	906.3	905.2	29.64
4	10.35	50.24 8.51.6		0	10	9.1	493.2	492.2	16.15
5	11.27	8.60 8.60	100/100	0	8	6.0	1209.7	1208.7	39.51

No.	Time	Temp of A	Temp of B	Mean	Diff. temp t	Diff. heat Sensible	Diff. heat Latent	Diff. vol.
1	9.50	10.8	11.6	22.4	16.6°C	10.6	1.4	
2	10.35	15.4	14.1	27.5	51.5°	{314.9 / 45.5}	{5.1 / 6.5}	
3	11.27	10.3	10.7	21.0	6.0			

Assuming that $\rho = a + bt + ct^2$

we have
$$a + 6.1b + 37.22c = 50.6$$
$$a + 22.96b + 522.4c = 33.5$$
$$a + 53.46b + 2851.6c = 20.6$$

whence
$$a = +58.56 \qquad 1.3315$$
$$b = -1.383 \qquad 1.2413$$
$$c = +0.0126 \qquad 1.3316$$

Meter Tests contd —

(54)

Wednesday October 17th

Collected of the last of 30% solution (16.5% salt) 1000 c.c. of density 1.127 @ 19.6°C. and added 500 c.c. of distilled water to reduce it to 20% solution (11.0% salt) whose density by bottle is 1.065 @ 20°C and observed to be 1.056 @ 20.7°C by hydr
1.054 @ 21.2°C " balance

Electrodes 167.5 cms apart

No. of obs.	Time	Sol. temp.	Bridge	Res. in ohms	Mean Res. fall	Mean Res. bottle	T.Z. corrected	F.Z. corrected	sp. r.
1	10.34	20.4 & 22.0 / 22.4	100/100 / 70/220	6400	·1	0.5	1018.7	1012.7	34.13
2	·35			500	5	4.5	1030.7	1028.7	33.63
3	·36			0	·7	3.5	1027.7	1025.7	33.54
4	·38	20.53.6 / 6.53.2	100/100	0	10	9.8	630.7	620.7	20.62
5	11.57	A 5.9 / B 6.2	100/100	0	7	3.5	1539.7	1536.7	50.55

No. of obs.	Time	Height of meniscus A	B	Sum	Mean temp.	Diff temp.	Diff. temp. from mean	Diff. sp. gr.	
1	10.35	11.85	11.3	23.15	22.8	16.7	1.45		
2	10.58	13.8	13.8	27.6	53.4	{30.6 / 47.3}	{3.45 / 5.9}		
3	11.57	16.8	10.9	21.7	6.1				

Water Tests. Zenith –
October 17th Wednesday.

Collected 1000 c.c. of the last or 20% sol. (11% salt) in copper and added 1000 c.c. of H_2O dist: to reduce it to 10% sol (5.5% salt) whose tabular density is 1.032 the desired density being 1.043 by Hydr @ 19.9°C
1.043 – balance @ 20.5°C

Electrode 167.5 apart

No.	Time	Sol. temp	Bridge	Thermo-ed	Min. the bottle	Min. the tube	T.I. cells	F.I. cells	cf.	
1	14.15	10% 18.8 20.1	100 from 26.6°	7408	1	0.5	1780.7	1772.7	57.99	
2	·17			100	100	2.5	1758.7	1754.7	57.35	
3	·19			0	5	2.5	1757.7	1754.7	57.33	
4	·42	S 20 6 20.6		0	5	2.5	1027.7	1024.7	34.26	
5	15.18	S 5.0 6 10.1		0	5	2.5	2018.7	2014.7	65.88	

No.	Time	Height of Manometer A	B	Sum	Mean Temp	Diff Temp	Diff bad sum	Diff vol.	
1	14.15	10.6	10.2	20.8	19.6	4.55	0.70		
2	14.42	12.95	12.55	25.50	51.9	[22.3 26.22]	[4.70 5.50]		
3	15.18	10.4	10.1	20.5	15.05				

Calculations for the carrying capacity of 30 # 9 wire B.W.G galvanized iron d. 1.48" = 0.376 cm. diam + 800 feet = 24400 cm long.

800 ampere ÷ 30 = 26.7 amperes per wire.

1 wire of galvanized iron wire offers $\frac{360\,000 \times 800}{(1.48)^2 \times 5280}$ at 60°F

$= \frac{3.6 \times 10^5 \times 8.0 \times 10^3}{2.19 \times 10^4 \times 5.28 \times 10^3} = \frac{28.8 \times 10^7}{11.56 \times 10^7} = 2.49\,\Omega$ say 2.5

By Geneva tables $\frac{16.4 \times 800}{5280} = \frac{13.12}{5.28} = 2.53$

at 100 volt therefore each wire will take initially 40

The limiting temp of the wire under these conditions will be

$$\theta = \frac{4\,C^2\rho(1+0.0058)}{J\pi^2 d^3 k} \qquad \theta\,(J\pi^2 d^3 k - 0.20\,C^2\rho) = 40^2\rho$$

$$\theta = \frac{40^2\rho}{J\pi^2 d^3 k - 0.20\,C^2\rho}$$

Here $\rho = \frac{16.4 \times 10^7 \times 0.11124}{16\,093} = \frac{1.64 \times 1.110}{1.609} \times 10^{14} = 1.13 \times 10^{14}$

C = say 4

$k = 3 \times 10^{-4}$

$J = 4.2 \times 10^7$

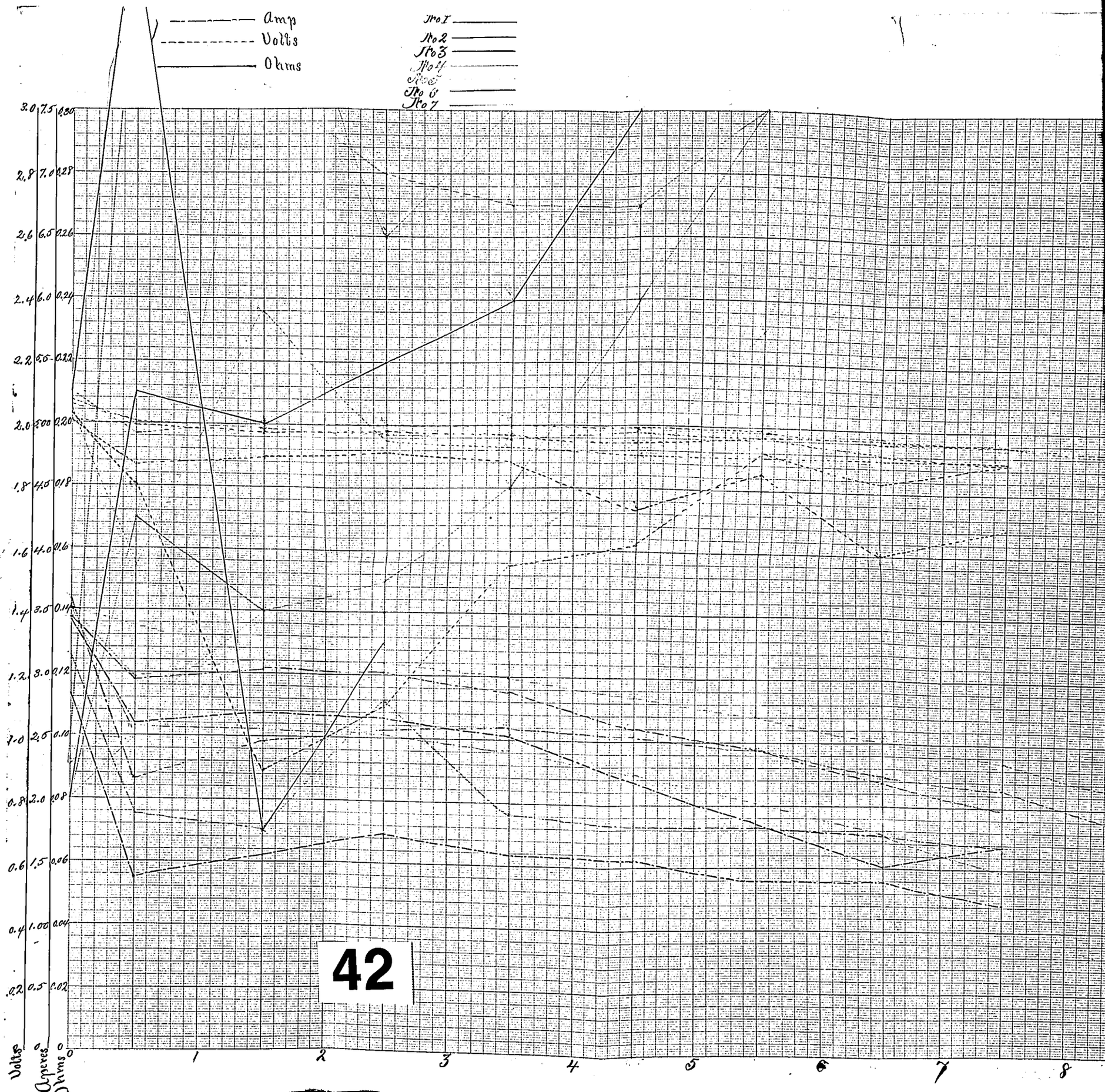
$d = 3.76 \times 10^{-1}$

$$\theta = \frac{4 \times 16 \times 1.13 \times 10^{14}}{4.2 \times 10^7 \times (3.76)^3 \times 10^{-3} \times 9.87 \times 3.0 \times 10^{-4} - 2.0 \times 1.6 \times 1.13 \times 10^{14}}$$

$$= \frac{7.23 \times 10^5}{4.2 \times 5.316 \times 9.87 \times 3.0 \times 10 - 2.0 \times 1.6 \times 1.13 \times 10^{14}}$$

$$= \frac{7.23 \times 10^5}{6.61 \times 10^7 - 3.62 \times 10^3} = 2.40°\,C \text{ rise at most}$$

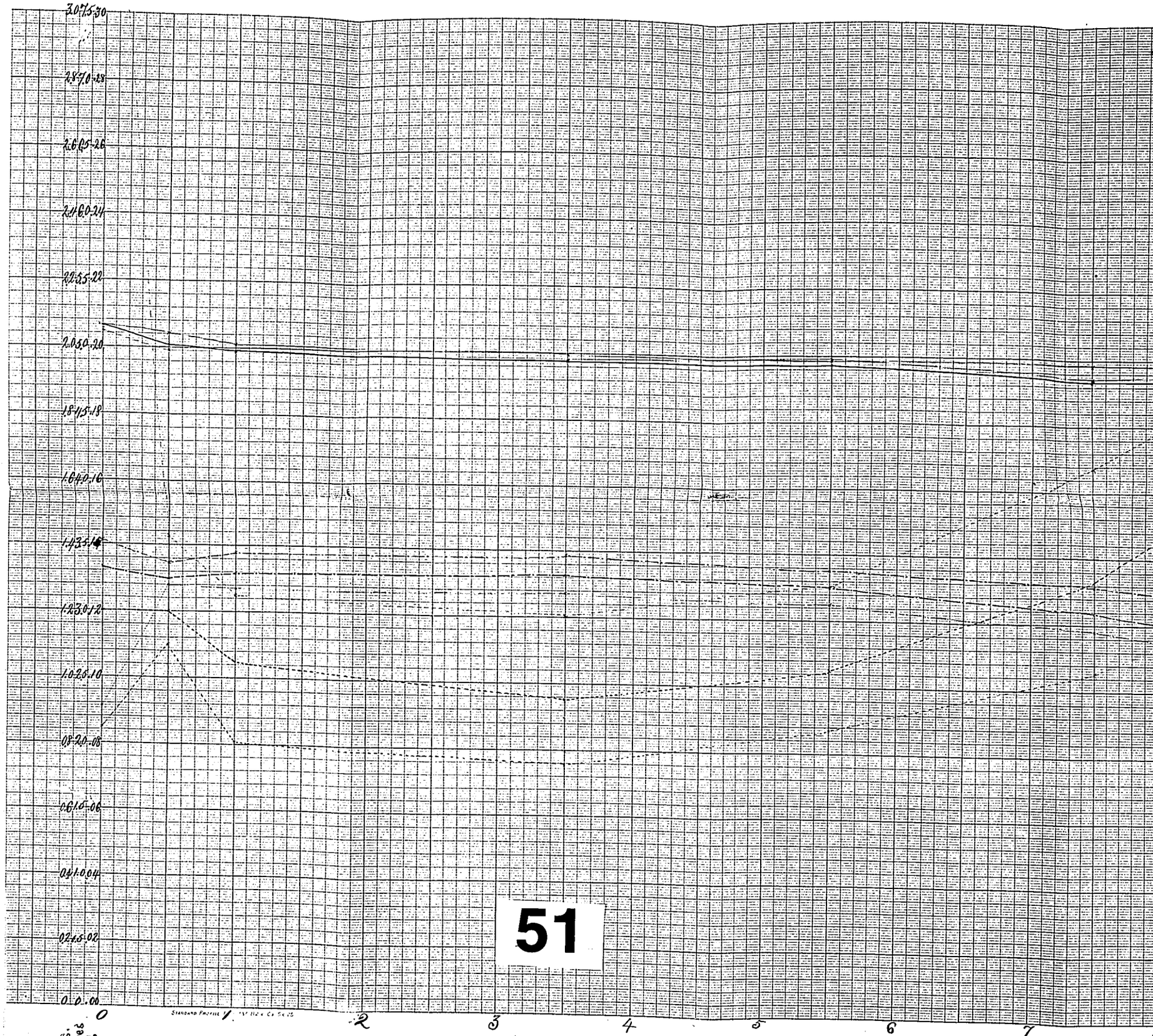
at which temp: it would have a sp. res. of $2.2 \times 1.13 \times 10^{14}$ ohms and the res: of 800 feet would be $\frac{2.486 \times 10^{14} \times 2.45 \times 10^{4}}{3.11 \times 10^{-1}}$ $= 5.1465\,\Omega$ and the limiting current 20 ampere.

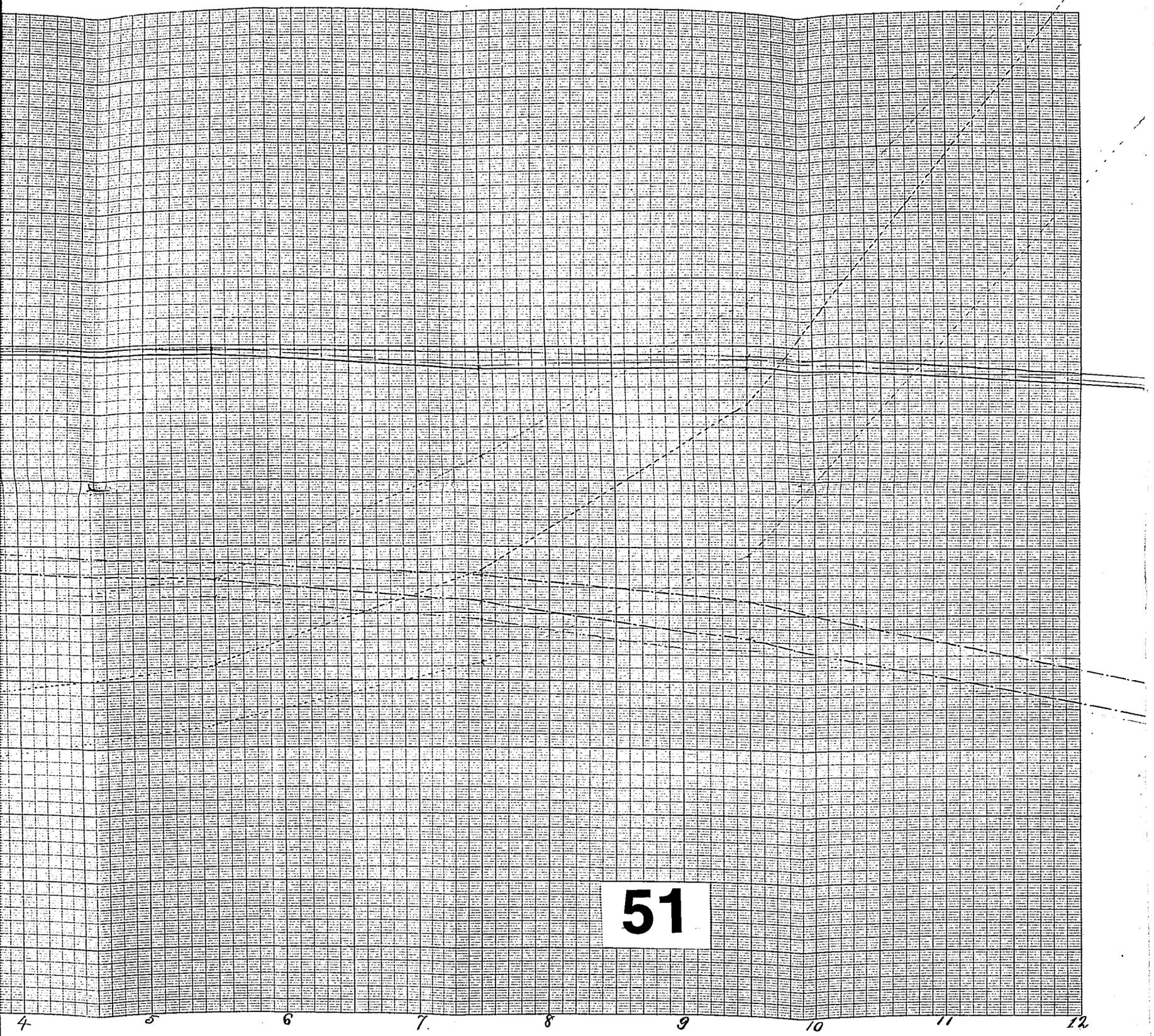

Amp
Volts
Ohms
No 1
No 2
No 3
No 4
No 5
No 6
No 7
Volts
Amperes
Ohms
3.0 7.5 0.30
2.8 7.0 0.28
2.6 6.5 0.26
2.4 6.0 0.24
2.2 5.5 0.22
2.0 5.00 0.20
1.8 4.5 0.18
1.6 4.0 0.16
1.4 3.5 0.14
1.2 3.0 0.12
1.0 2.5 0.10
0.8 2.0 0.08
0.6 1.5 0.06
0.4 1.00 0.04
0.2 0.5 0.02
0 0 0
0 1 2 3 4 5 6 7 8
42

No 1
No 2
No 3

Amperes
Ln. Resist.
Volts.

Oct. 17. 1888



Volts.
Amperes
Ohms

Oct. 17. 1888